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The Use of Specialized Laboratory Facilities for Science in Elementary Schools: A Call for Research

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Abstract

The reforms call for elementary science that engages students in meaningful and relevant learning opportunities for all students. While science lab facilities are common to middle and high school, in elementary schools, science is typically taught in the regular classroom. Elementary schools across the nation, however, have devoted financial and other resources to establishing separate laboratory facilities for science. How do these facilities support the delivery models for elementary science instruction and aid in meeting the vision of the reforms? The lack of research in this area should be addressed to enable districts to make informed decisions about whether to allocate funds to establishing separate facilities or equipping regular classrooms for elementary science instruction.

Introduction

In its official position statement, the National Science Teachers Association (NSTA) endorsed the "necessity [sic] of laboratory experiences for teaching and learning in science . . ." and stated, "adequate support for materials, equipment, and teacher time must be available to schools to maintain quality science instruction" (1991, p. 42). More recently, the National Science Education Standards (NSES) (NRC, 1996) emphasize that teachers should design and manage learning environments that provide students with the time, space, and resources needed for learning science. Despite these emphases, however, research reveals that relatively little class time—less than 30 minutes per day—is spent on science instruction in elementary schools (Fulp, 2002). Comparison of results from the 1993 and 2000 National Survey of Science and Mathematics Education (Smith, Banilower, McMahon, & Weiss, 2002) suggests that there has been little change in science instruction in the nation as a whole since the publication of the NSES.

A variety of factors contribute to this problem. Most notably, elementary teachers' anxiety and negative attitudes about teaching science have been well-documented (Czerniak & Chiarelott, 1990; Westerback, 1982). For example, while 77% of elementary teachers consider themselves "well-qualified" to teach language arts/reading, fewer than 3 in 10 indicate that they feel "well-qualified" to teach science (Weiss et al., 2001). This may lead to teachers' avoidance of teaching science (Tilgner, 1990). It stands to reason, however, that even those elementary teachers who do feel confident teaching science may encounter barriers to doing so, such as a lack of materials and inadequate facilities.

A national study by the U.S. General Accounting Office (1995) provides strong evidence that inadequate facilities for science instruction are a widespread concern.

Forty percent of schools nationwide reported that their facilities could not meet the functional requirements of laboratory science. More recent data from the 2000 National Survey of Science and Mathematics Education suggests that along with lack of content preparation, inadequate facilities and equipment and lack of money to purchase consumable supplies are barriers to the effective and equitable teaching of science (Weiss et al., 2002). Twenty percent of the schools in the survey cited facilities as a "serious problem" for science and mathematics instruction. This is consistent with earlier research by Hove (1970, as cited in Tilgner, 1990) indicating that the obstacles to teaching science most frequently cited by elementary teachers were inadequate teacher background in science, inadequate science equipment, and inadequate time and space. This is also supported by more recent research by Eriksson (1997), indicating preservice elementary teachers view allotted time and space as potential barriers in their future science teaching. Indeed, teachers themselves have written articles in professional journals about how to cope with less-than-adequate facilities (e.g., Mackin & Williams, 1995).

One major difference between elementary and middle or high schools is the nature of the classroom. Most elementary school classes are "self-contained," and a single teacher is responsible for teaching all or most of the academic subjects to a single group of students. Thus, science is usually taught in the regular classroom, as opposed to specialized science laboratories, as is usually the case in middle and high schools; however, it is not unheard of for elementary schools to have separate laboratory facilities for science (Beihle, Motz, & West, 1999; Fehlig, 1996; Fox, 1994; Harbeck, 1985; Vorsino, 1992). A Google™ search for "elementary science lab" quickly yields numerous examples. As one elementary school's webpage advertises, . . .

> Elementary principals are well aware of the call for "back to basics" and emphasis on state assessments in reading and math. Unfortunately, many times, we find subjects such as science are somewhat neglected in the primary curriculum. That is distressing, especially when you consider the curiosity and wonderment science can ignite in a young person's mind. One way we bring the tangible thrill and mystery of science to our students' lives is through an elementary science lab. Our "Exploration Station" resembles a science museum, with interesting visual displays, a wide variety of foliage, fascinating animals, and engaging hands-on learning activities. The lab has become a source of pride for our school, and we delight in seeing many of our students embark on a lifetime love of science simply through exposure to real-life applications (Student Activities: Deer Park Elementary).

How do separate facilities for science support and contribute to ensuring adequate and appropriate instruction at the elementary level? This article will explore what insights research already provides in terms of answering these questions, as well as the questions that are raised in these studies. The article concludes with a call for research to determine how facilities can be best utilized within different delivery models for elementary science instruction.

Laboratories for Elementary Science Instruction

As far back as 1954, the NSTA's School Facilities for Science Instruction discussed the problem of deciding whether to place the facilities for science in the regular classroom where most other activities are held or to use a separate

room. The flexibility of the regular classroom is emphasized; there must be enough space and materials to accommodate a wide range of activities, and the "unique needs of science teaching should be anticipated in planning such general features as . . . illuminating, ventilating, plumbing, and electrical services" (Richardson, 1954, p. 8). The authors put forth the idea that science should be taught in the regular classroom "as far as possible" but acknowledge that because not all regular classrooms may be equipped to meet the needs of science instruction, some activities must be provided elsewhere.

> While the separation of the facilities for experiences in science from the room where other activities are carried on has undesirable features, it is better to have such separated facilities than none at all. The planning of a new building should ordinarily provide for science facilities within the room. The conversion of existing facilities should likewise include provisions for science experiences within the elementary room, but in exceptional cases, it may be necessary to use a separate room (1954, p. 165).

Yet, no further clarification of the "undesirable features" is given, and the reader is left to draw inferences about what these might be.

A review of the research yields little information about the utilization of separate facilities for science in elementary schools. Part of the difficulty is the nature and use of the word *laboratory* itself. In terms of this literature review, *laboratory* is intended to mean a specialized facility in which science instruction takes place; however, *laboratory* has a variety of other meanings and usages within the literature. Often, *laboratory* refers to activities carried out by students, rather than the facilities in which those activities take place. For example, Hofstein and Lunetta (1982) define *laboratories* as "contrived learning experiences in which students interact with materials to observe phenomena" (p. 202). In addition, *laboratory* has been used in terms of a teaching method (laboratory method as opposed to lecture method) (Linn, 1997). A review of the literature yielded only three studies that use the term *laboratory* to denote specialized science facilities within elementary schools. One specifically examines the implementation and utilization of the science laboratory for instruction by regular classroom teachers (Vorsino, 1992), while the other two mention laboratory facilities in terms of delivery models that utilize science specialists (Jones & Edmunds, 2006; Schwartz, Abd-El-Khalik, & Lederman, 2000).

Vorsino (1992) examined the implementation and usage of a separate science laboratory facility in the school for which she served as assistant principal. In her district, the cost of hiring specialists was prohibitive in light of recent budget cuts; therefore, rather than being designated as a room in which specialists would teach science, the laboratory was set up for use by classroom teachers. A variety of problems prevented successful implementation of the laboratory (Vorsino, 1992). These spanned a wide range of issues, and in some cases, the laboratory created new problems related to those it was designed to address—specifically, the availability of materials.

The science laboratory had been equipped with nonconsumable materials; as Vorsino pointed out, the problem for many teachers became the expense of purchasing consumable supplies required for many of the science laboratory activities. Even more so, finding sufficient storage in the laboratory for consumable supplies became another issue. Other problems were related to the location of the laboratory within the school (Vorsino, 1992). Some teachers believed travel time detracted from the instructional benefits of the lab. The kindergarten classrooms

were located across the school campus from the laboratory. Behavior problems, compounded by increased class size, occurred en route to and from the laboratory. As a result, kindergarten teachers decided not to use the laboratory and conducted science activities in their regular classrooms.

The logistics of sharing the lab facility among the faculty was also an issue. A lab schedule was arranged, but problems arose in arranging special assemblies or programs in the laboratory during teachers' time slots. In addition, although each class was scheduled for a laboratory session, the laboratory was not being used on a regular basis. It could be inferred that frustration with securing a desirable time slot led to this lack of use; however, Vorsino also speculated the newness of the laboratory itself may have seemed daunting, and unfamiliarity with science laboratories may have caused teachers to avoid using it. Thus, barriers to effective science teaching mentioned previously (lack of content preparation) may still be a barrier within a specialized science laboratory setting.

In their study, Schwartz et al. (2000) sought to evaluate the effectiveness of hiring specialists to teach science in equipped elementary science rooms. In their evaluation, the researchers determined that specialists' views of elementary science instruction were more aligned with the reforms vision for elementary science instruction than those of the regular classroom teachers and that the apparent absence of constraints to teaching science (e.g., adequate planning time, materials, space, etc.) voiced by classroom teachers suggests specialists could play a significant role in achieving reform. The researchers also acknowledge, however, that the cost of hiring specialists might also serve as a barrier for some school districts. It is not clear whether the cost of the specialists or the cost of the facilities was more of an issue because the researchers did not examine these aspects separately. In addition, it is difficult to draw any conclusions from this study about how effectively laboratory facilities would be utilized without the specialists.

Similarly, Jones and Edmunds (2006) explored three different models for elementary science instruction, two of which included a school science laboratory. In the "Resource Model," the lab housed teacher and student resource books, as well as manipulatives, kits, and consumable materials, all of which were available for classroom teachers' use. As Jones and Edmonds report, "the teachers and the principal feel that the lab provides the necessary resources for science instruction to happen in the classroom" (p. 325). This model facilitated interdisciplinary instruction and fostered collaboration between the science resource teacher and classroom teachers. In contrast, the "Science Instructor Model" involved a specialist who taught in her own science laboratory (similar to Schwartz et al., 2000). Though other teachers were held responsible for teaching science, there were concerns that some teachers might avoid doing so because of the presence of the science specialist. Despite these differences, the authors argued that both of these models resulted in a more significant "presence for science" within the two buildings, particularly in comparison to a more traditional "Classroom Teacher Model" of elementary science instruction.

A Need for Research

According to the NSES (NRC, 1996), ". . . effective science teaching depends on the availability and organization of materials, equipment, media, and technology" and ". . . the arrangement of available space and furnishing in the classroom or laboratory influences the nature of the learning that takes place" (p. 44). Currently, research in science education yields no clear answers about the way

in which separate science facilities in elementary schools contribute to achieving the reforms vision put forth by the NSTA and the standards. Research by Vorsino (1992) suggests that while laboratory facilities may be designed to address barriers to effective science teaching, some barriers will still exist, and implementing laboratories may in fact create a new set of barriers as well. Furthermore, research illustrates the importance of considering "effective" use of an elementary science laboratory in relation to the delivery model for instruction (Jones & Edmonds, 2006; Schwartz et al., 2000).

The overwhelming lack of research indicates a need for further study to examine how separate laboratory facilities in elementary schools play a role in effective delivery models for science instruction. Through closer examination or case study of elementary schools with laboratories, future studies should focus on broader questions such as the following:

- In what ways does the use of the science laboratory support the delivery model for science within the school?

- In what ways does the existence of the science laboratory contribute to a broader presence for science at the school?

Clearly this is not strictly a pedagogical issue. Determining the cost-effectiveness of separate laboratory facilities as opposed to better equipping regular classrooms to be more suitable for science is of importance not only in the construction of new schools, but in the remodeling and refurbishing of existing school facilities as well; therefore, researchers should also consider the following question:

- In what ways does the science lab facilitate the flow of resources, financial and otherwise, to the school science program?

As districts across the nation seek out innovative ways to enhance the educational opportunities of K-6 students in science, it is important that they have access to evidence that can inform their decisions. We, as science education researchers, can play an important role in providing this information through our research efforts.

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